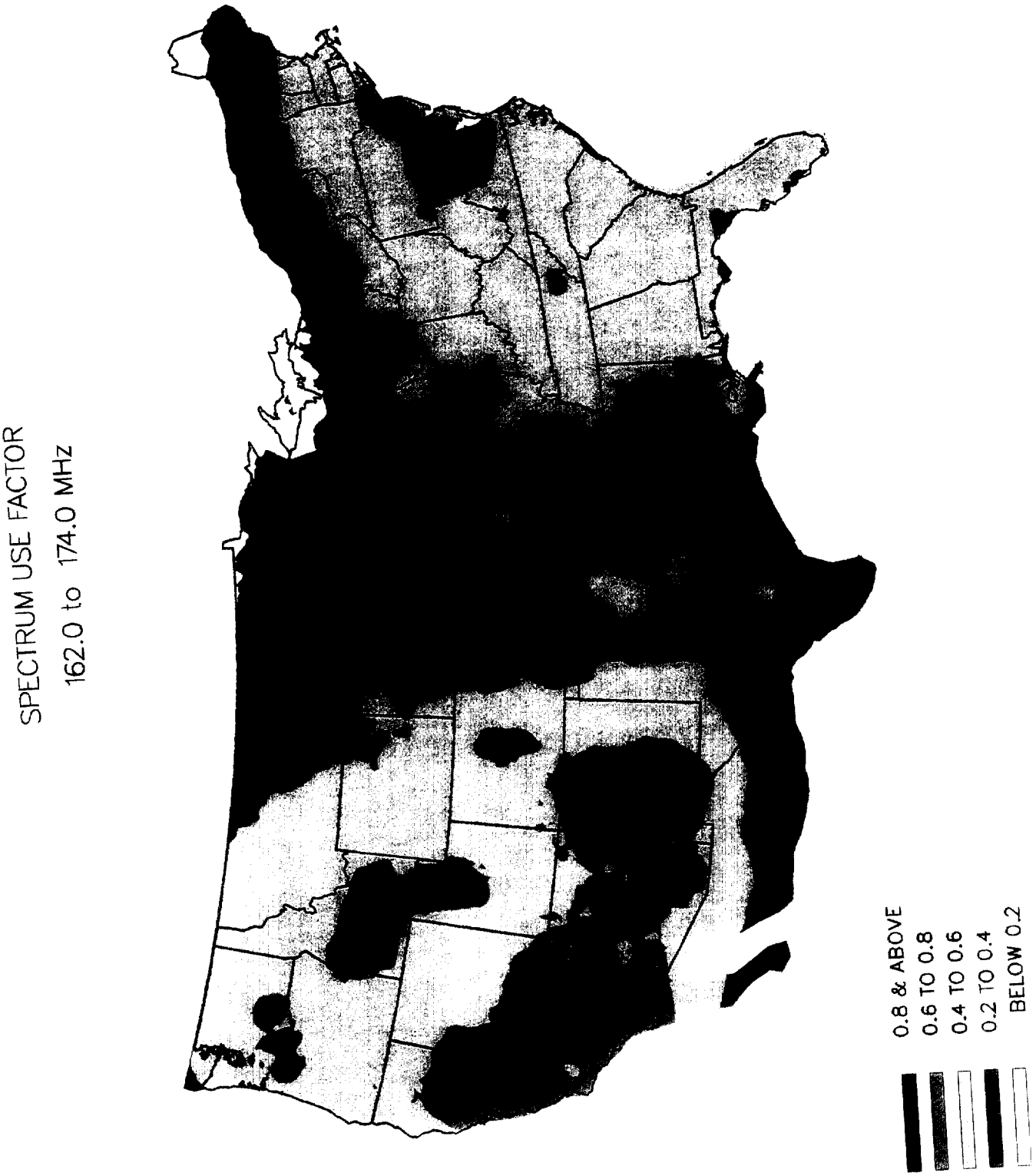

Figure 2-3. Spectrum Use Factor for the 162.0 - 174.0 MHz band.

Figure 2-4. Spectrum Use Factor for the 450.0 - 470.0 MHz band.

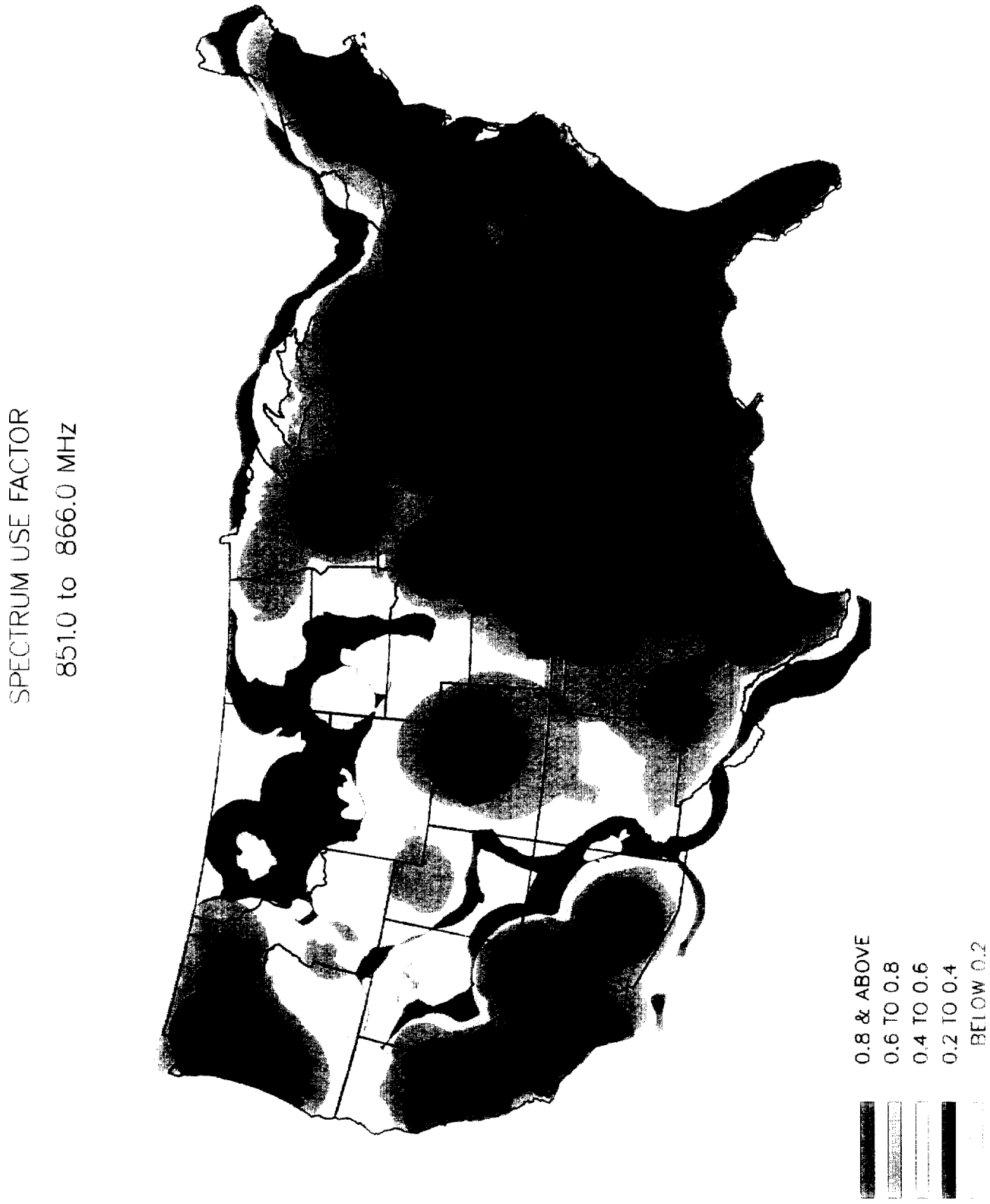

Figure 2-5. Spectrum Use Factor for the 851.0 - 866.0 MHz band.

APPENDIX B

Appendix B

The attached analysis is an indication of PMRS frequency availability in the 450-470 MHz, 470-512 MHz, and 800/900 MHz bands. The top 10 urban areas were selected, and the geographical coordinates shown are for the approximate center of the urban areas.

Since all frequencies below 470 MHz are allocated on a shared basis, it is difficult to state if a frequency is available or not. Therefore, a random sampling of 450-470 MHz frequencies from the various "pre-refarming" Radio Services was selected, and the number of transmitters authorized within the search radius was reported.

Search Radius:	82 km (50 miles) radius.
Pools:	The Industrial/Land Transportation Pools were used for the 800/900 MHz band analysis. The "post-refarming" Industrial/Business Pool was used for the 470-512 MHz, identifying only the 25 kHz channels.
Frequency Availability:	Number of 800 MHz, 900 MHz or 470-512 MHz frequencies that are currently not licensed within the search radius.
Co-Channel Users:	Indicates the number of transmitters licensed within the search radius. We have noted those cases in which a single transmitter indicates multiple users on a Community Repeater (FB4).

URBAN AREA
ANALYSIS

NEW YORK		NOTES
40-45-06/073-59-39		
	FREQUENCIES AVAILABLE	
800 MHZ	0	
900 MHZ	0	
470-512 MHZ	0	
	CO-CHANNEL USERS	
451.0250 MHZ	6	
451 1750 MHZ	10	
451.3000 MHZ	8	
451.7250 MHZ	11	1
452.0500 MHZ	8	
452.5500 MHZ	2	
452.7250 MHZ	8	
452.9250 MHZ	0	
462.3250 MHZ	14	2
463.8750 MHZ	15	

1. 1 Transmitter equals 7 users on an FB4
2. 1 Transmitter equals 4 users on an FB4

URBAN AREA
ANALYSIS

LOS ANGELES		NOTES
34-03-15/118-14-28		
	FREQUENCIES AVAILABLE	
800 MHZ	0	
900 MHZ	0	
470-512 MHZ	0	
	CO-CHANNEL USERS	
451.0250 MHZ	6	
451 1750 MHZ	6	
451.3000 MHZ	13	
451.7250 MHZ	5	
452.0500 MHZ	10	
452.5500 MHZ	4	
452.7250 MHZ	4	
452.9250 MHZ	2	
462.3250 MHZ	12	
463.8750 MHZ	13	1

1. 2 Transmitter equals 10 users on an FB4.

URBAN AREA
ANALYSIS

CHICAGO			NOTES
41-52-28/087-38-22			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	3	
	451.1750 MHZ	12	
	451.3000 MHZ	5	
	451.7250 MHZ	6	
	452.0500 MHZ	1	
	452.5500 MHZ	1	
	452.7250 MHZ	3	
	452.9250 MHZ	0	
	462.3250 MHZ	12	
	463.8750 MHZ	6	1

1. 1 Transmitter equals 6 users on an FB4.

URBAN AREA
ANALYSIS

PHILADELPHIA			NOTES
39-56-58/075-09-21			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	2	
	451.1750 MHZ	9	
	451.3000 MHZ	4	
	451.7250 MHZ	8	1
	452.0500 MHZ	3	
	452.5500 MHZ	2	
	452.7250 MHZ	2	
	452.9250 MHZ	1	
	462.3250 MHZ	19	
	463.8750 MHZ	9	

1. Transmitter equals 4 users on an FB4.

URBAN AREA
ANALYSIS

DETROIT			NOTES
42-19-48/083-02-57			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	3	
	451.1750 MHZ	5	
	451.3000 MHZ	4	
	451.7250 MHZ	4	
	452.0500 MHZ	5	
	452.5500 MHZ	2	
	452.7250 MHZ	3	
	452.9250 MHZ	0	
	462.3250 MHZ	10	
	463.8750 MHZ	5	

URBAN AREA
ANALYSIS

BOSTON			NOTES
42-21-24/071-03-25			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	5	
	451.1750 MHZ	5	
	451.3000 MHZ	4	
	451.7250 MHZ	6	
	452.0500 MHZ	2	
	452.5500 MHZ	4	
	452.7250 MHZ	3	
	452.9250 MHZ	0	
	462.3250 MHZ	12	
	463.8750 MHZ	9	1

1. 1 Transmitter equals 3 users on an FB4

URBAN AREA
ANALYSIS

SAN FRANCISCO			NOTES
37-46-39/122-24-40			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	4	
	451.1750 MHZ	2	
	451.3000 MHZ	12	
	451.7250 MHZ	4	1
	452.0500 MHZ	3	
	452.5500 MHZ	3	
	452.7250 MHZ	4	
	452.9250 MHZ	0	
	462.3250 MHZ	4	
	463.8750 MHZ	10	

1. Transmitter equals 2 users on an FB4.

URBAN AREA
ANALYSIS

WASHINGTON, DC 38-53-51/077-00-33		NOTES
	FREQUENCIES AVAILABLE	
800 MHZ	0	
900 MHZ	0	
470-512 MHZ	0	
	CO-CHANNEL USERS	
451.0250 MHZ	8	
451.1750 MHZ	5	
451.3000 MHZ	1	
451.7250 MHZ	5	
452.0500 MHZ	4	
452.5500 MHZ	1	
452.7250 MHZ	2	
452.9250 MHZ	0	
462.3250 MHZ	4	
463.8750 MHZ	14	

URBAN AREA
ANALYSIS

DALLAS/FT. WORTH			NOTES
32-47-09/096-47-37			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	3	
	451.1750 MHZ	3	
	451.3000 MHZ	2	
	451.7250 MHZ	3	
	452.0500 MHZ	1	
	452.5500 MHZ	0	
	452.7250 MHZ	2	
	452.9250 MHZ	1	
	462.3250 MHZ	5	
	463.8750 MHZ	10	

URBAN AREA
ANALYSIS

HOUSTON			NOTES
29-45-26/095-21-37			
		FREQUENCIES AVAILABLE	
	800 MHZ	0	
	900 MHZ	0	
	470-512 MHZ	0	
		CO-CHANNEL USERS	
	451.0250 MHZ	3	
	451.1750 MHZ	5	
	451.3000 MHZ	3	
	451.7250 MHZ	2	
	452.0500 MHZ	2	
	452.5500 MHZ	1	
	452.7250 MHZ	1	
	452.9250 MHZ	1	
	462.3250 MHZ	3	
	463.8750 MHZ	6	1

1. 1 Transmitter equals 3 users on an FB4

APPENDIX C

Appendix C

Refarming Effectiveness Projection

Year	% of 25 kHz Systems	% of 12.5 kHz Systems	% of 6.25 kHz Systems	Effective Net Bandwidth (kHz)	Spectrum Use Improvement Factor
1997	100	0	0	20.00	1.00
1998	91	8	1	19.13	1.05
1999	82	16	2	18.26	1.10
2000	73	24	3	17.39	1.15
2001	64	32	4	16.52	1.21
2002	55	40	5	15.65	1.28
2003	46	48	6	14.78	1.35
2004	37	56	7	13.91	1.44
2005	28	64	8	13.04	1.53
2006	19	72	9	12.17	1.64
2007	10	80	10	11.30	1.77
2008	9.1	72	18.9	10.69	1.87
2009	8.2	64	27.8	10.07	1.99
2010	7.3	56	36.7	9.46	2.12
2011	6.4	48	45.6	8.84	2.26
2012	5.5	40	54.5	8.23	2.43
2013	4.6	32	63.4	7.61	2.63
2014	3.7	24	72.3	7.00	2.86
2015	2.8	16	81.2	6.38	3.13
2016	1.9	8	90.1	5.77	3.47
2017	1	7	92	5.57	3.59
2018	0.9	6	93.1	5.50	3.64
2019	0.8	5	94.2	5.42	3.69
2020	0.7	4	95.3	5.35	3.74

APPENDIX D

Appendix D1

Advanced Services Penetration Estimation in Year 2010

Type of Service	Police	Fire	EMS	Average "heavy" User	General Govt. User	Average "Light" User	Average "Medium" User
W.B. DATA	23	28	31	27.33	1	1	14.17
VIDEO	14	20	17	17.00	3	3	10.00

Average "medium" users = average of heavy/light.
W.B. Data = Wide Band Data

Appendix D2

Radio Projections of Current Services* in Year 2000, 2004 and 2010 for L.A. County

Market Projections for L.A. County	# of Workers in 1995	# of Radios in 1995	Penetration Rate of Workers using Radios	Est.** Growth Rate of Current Services	# of Radios in 2000	# of Radios in 2004	# of Radios in 2010
Total	3,499,322	300,408	8.6	5.2	347,756	425,657	576,071

*Current services are voice, slow speed data and status/message.
**The 1995-2000 growth rate is assumed to be approximately 60% of long term to account for assumed market "chilling" due to various factors including user uncertainty relative to "refarming" FCC resolutions, licensing freezes and auction issues at 800/900 MHz, coordination pool consolidation resolutions, development of new coordinator software and inter-coordinator networks, etc.

Appendix D3

Projected Penetration of Advanced Services and Radio Units

Penetration of Advanced Services [% of Voice Radio Users]		Penetration of Advanced Services in Units					
Yr. 2010 W.B. Data	Yr. 2010 Video	Yr. 2000 W.B. Data	Yr. 2000 Video	Yr. 2004 W.B. Data	Yr. 2004 Video	Yr. 2010 W.B. Data	Yr. 2010 Video
17.25*	11.64*	6,325	4,221	7,766	5,166	99,417	67,071

* Varies from 1-27.3%, depending on the market.
** Varies from 3-17%, depending on the market.
Year 2000 penetration is assumed 1/10 of year 2010.
[Numbers not exact multiplicity due to market rounding errors.]

APPENDIX E

Appendix E

Year 2000 Spectrum Requirements *

Service	Erlangs per Unit	No. of Units	SRC, kbps	COD	Rate, b/s/Hz	Load, %	Reuse	Error, %	MHz of Spectrum
VOICE	0.0242	347756	6	1	0.75	54.5	4	54	67.17
DATA	0.00435	173878	6	1	0.75	54.5	4	54	6.035
STAT/ MSG	0.0004	173878	6	1	0.75	54.5	4	54	0.55
W.B. DATA	0.007	6345	384	2	2	54.5	4	54	4.24
VIDEO	0.012	4221	384	2	2	54.5	4	54	4.85
								Sub-Total	82.85
								Less Commer. Services	-7.32
								Ttl. Reqd.	75.5
								Less Existing	-60.50
								FINAL	15.0

Notes:

1. The above factors are estimates for year 2000, and demonstrate less technology improvement than for year 2010.
2. Data and status message are estimated at a penetration of half voice.
3. Reuse factor for current services is higher than year 2010 and represents the more crowded, reduced communications quality of today/near future PLMR service.

Year 2004 Spectrum Requirements *

Service	Erlangs per Unit	No. of Units	SRC, kbps	COD	Rate, b/s/Hz	Load, %	Reuse	Error, %	MHz of Spectrum
VOICE	0.026	425653	6	1	0.8	54.5	4	54	83.23
DATA	0.0076	212827	6	1	0.8	54.5	4	54	12.07
STAT/ MSG	0.0004	212827	6	1	0.8	54.5	4	54	0.63
W.B. DATA	0.0126	7766	384	2	2.2	54.5	4	54	8.48
VIDEO	0.0216	5166	384	2	2.2	54.5	4	54	9.70
								Sub-Total	114.03
								Less Commer. Services	-9.59
								Ttl. Reqd.	104.4
								Less Existing	-60.50
								FINAL	44

Notes:

1. The above factors are estimates for year 2004, and demonstrate less technology improvement than for year 2010.
2. Data and status message are estimated at a penetration of half voice.
3. Reuse factor for current services is higher than year 2010 and represents the more crowded, reduced communications quality of today/near future PLMR service.
4. The calculated spectrum need is consistent with the 1993 cope prediction, assuming 1/3 of the predicted 75 MHz requirement there was for public safety.

Year 2010 Spectrum Requirements *

Service	Erlangs Per Unit	No. of Units	SRC, kbps	COD	Rate, b/s/Hz	Load, %	Reuse	Error, %	MHz of Spectrum
VOICE	0.035	576071	6	1.25	1	54.5	3.5	50	101.47
DATA	0.0087	288036	6	1	1.5	54.5	3.5	50	10.51
STAT/ MSG	0.0004	288036	6	1	1.5	54.5	3.5	50	0.48
W.B. DATA	0.014	99417	384	3	3.5	54.5	4	50	46.70
VIDEO	0.024	67071	384	3	3.5	54.5	4	50	54.01
								Sub-Total	213.17
								Less Commer. Services	-27.16
								Ttl. Reqd.	186.0
								Less Existing	-60.50
								FINAL	125.5

Notes:

1. Estimates utilize PSWAC technology factors, modified for non-public safety conditions.
2. Data and status message are estimated at a penetration of half voice.
3. Reuse factors for current services are assumed slightly higher than PSWAC due to assumed more crowded conditions than public safety, yet lower than year 2000/2004 based on assumptions of both improved communications quality yet less reuse due to interference between narrow channels.

*NOTE: The following equation was used to compute the amount of spectrum required:

$$\text{MHz Required} = \frac{\text{Erlangs Per Unit X No. of Units X SRC X 10}}{\text{COD X Rate X Load X Reuse X (100-Error)}}$$

where:

Erlangs Per Unit: A measure of traffic load, or the time that the user transmits on a channel, expressed as a ratio between 0.0 and 1.0. With 1.0 erlang the user transmits all the time and with 0.0 erlang the user never transmits. The Erlangs Per Unit is that factor averaged over all of the transmitters being considered.

No. of Units: The number of transmitters within the geographic area being considered that are in service over the time under consideration.

SRC, Kbps: The content of the source message to be transmitted is represented by the shortened form SRC. All messages are in digital format, and the units are kbps, (kilo-bits-per-second).

COD: This is a dimensionless factor of improvement in coding of the message into bits to be transmitted. This improvement will take place between now and the date for which the computation is made.

Rate, b/s/Hz: The rate at which data bits are transmitted over the air by the transmitter in each Hz of its RF channel bandwidth. The units are b/s/Hz, (bits-per-second-per-Hz).

Load, %: The average percent of time that the channels are occupied by a transmission from a user.

Reuse: The number of times the same RF channel is reused within the geographic area under consideration.

Error, %: The average amount of error coding and overhead that is applied to the digitally formated message before transmission. With 0% coding there are no bits added to the message, and with 50% coding, half of the transmitted bits will be dedicated to overhead, error mitigation and correction.